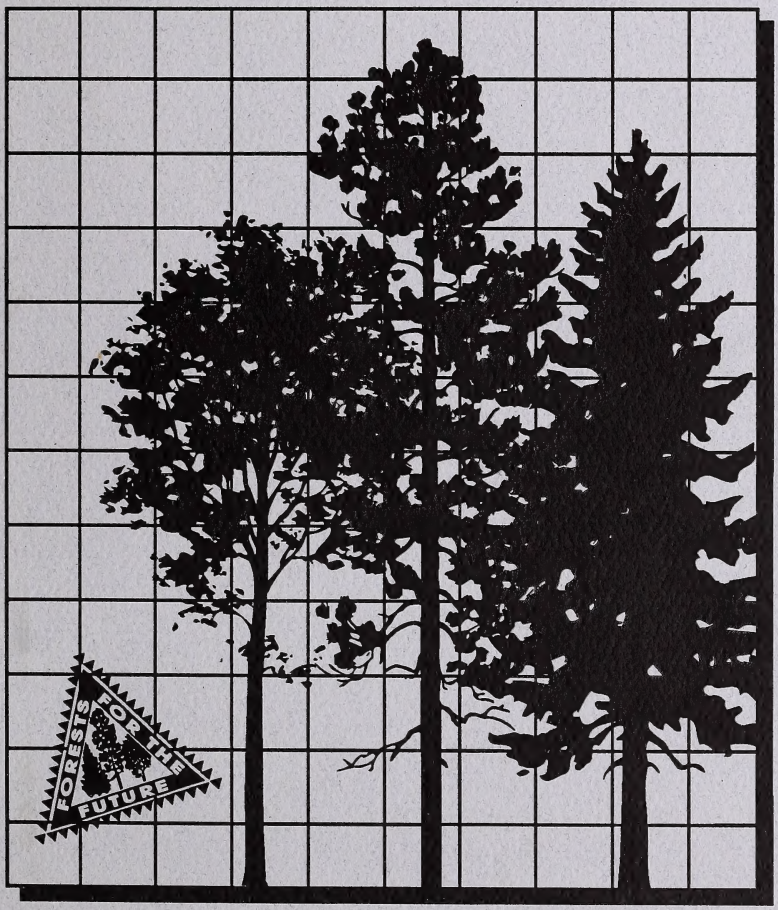
ALBERTA

REGENERATION

SURVEY MANUAL



1.0 INTRODUCTION

1.1 General

New reforestation regulations were legislated on March 1, 1991 to ensure establishment and growth of adequately stocked and evenly distributed timber regeneration. By using new regeneration standards, and operating under a proper management system, the resultant timber volume should duplicate or exceed natural forest yields.

This manual will explain the regeneration standards and survey procedures used to determine levels of regrowth of desireable tree species on harvested or otherwise denuded forest lands.

The new regeneration standards incorporate the following assessments: density, height and "Free to Grow" status (Free to Grow is a state in which coniferous crop trees are free from competition).

The following two independent surveys are required under the new standards: Establishment Survey (4 to 8 years after harvesting in coniferous and mixedwood cutblocks, 3 to 5 years after harvesting in deciduous cutblocks) and Performance Survey (8 to 14 years after harvesting in coniferous and mixedwood cutblocks only).

The Establishment Survey will show stocking amount (percent), density (stems/ha) and early growth (height) of regenerated timber, as well as the approximate locations of satisfactorily restocked (SR) and/or not satisfactorily restocked (NSR) areas larger than 4 ha.

The Performance Survey will measure the same variables as the establishment survey, and in addition will show the approximate locations of Free to Grow and/or not Free to Grow areas.

1.2 Applicability

These survey procedures are suitable for evaluating the stocking levels, growth rates and Free to Grow status on areas where the distribution of natural and/or introduced seedlings is random, or where it can be considered random. Generally, seedling distribution will be considered random on all areas except in established plantations where the spacing of the introduced seedlings is uniform between and within rows.

Regeneration surveys conducted on all public lands within the Province of Alberta for the purpose of fulfilling obligations under Sections 141.1(1)(2), 141.6, 141.7 and 141.8 of the Reforestation Regulations are to be carried out according to procedures provided in this manual unless otherwise specified by the Minister of Forestry, Lands and Wildlife.

1.3 Authority

The surveys are to be conducted under the authority of Section 141.2 of the Reforestation Regulations.

2.0 STANDARDS

2.1 Establishment Survey

2.1.1 Coniferous Standard

The Establishment Survey must be carried out 4 to 8 years after harvesting. Table 2.1 details the requirements for an acceptable established seedling on areas harvested primarily for coniferous timber.

An acceptable established seedling is a specific tree species that has reached a standardized height requirement, is alive, healthy and undamaged, and has grown on-site for a minimum of three years.

TABLE 2.1

Acceptable established seedlings for an area harvested primarily for coniferous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
White spruce	50
Engelmann spruce	50
Black spruce	50
Lodgepole pine	100
Jack pine	100
Whitebark pine	100
Limber pine	100
Larch (all species)	100
Douglas-fir	50

An acceptable established seedling may also consist of a live **spruce, pine, larch** or **Douglas-fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the following characteristics:

a. The tree shows good health and vigour, is undamaged, and will probably be alive and merchantable when the rest of the established trees are harvested.

b. The tree has a well-defined stem. Trees with multiple stems (more than two multiple stems at base) may not be recorded as established seedlings. Trees with more than three multiple lateral shoots not at the base may not be recorded as established seedlings.

c. The tree originated from seed rather than from layering (in deciduous species, suckering is acceptable in this category).

d. The crown covers two-thirds or more of the tree height and appears to be normal in form for the species. The crown cover requirement does not apply to deciduous trees.

A live **aspen, poplar, birch** or **fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the characteristics outlined above, may be considered a **conditional** established seedling.

Acceptable and conditional advanced growth must meet the minimum height requirements as set out in Tables 2.1 and 2.2.

TABLE 2.2

Conditional established seedlings for an area harvested primarily for coniferous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
All spruce species/Douglas-fir	40
All pine species/larch	75
Balsam fir	50
Alpine fir	50
Trembling aspen	150
Balsam poplar	150
White birch	150

Stocking

The basic sampling unit is considered stocked if it contains at least one acceptable established seedling, as outlined in Table 2.1.

An area harvested primarily for coniferous timber will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least one acceptable established seedling (Table 2.1). The stocked plots must be distributed evenly over the sample area; *or*

b. 60% of the sample plots are stocked with at least one acceptable established seedling (Table 2.1) and an additional 20% of the sample plots are stocked with at least one conditional established seedling (Table 2.2). The stocked plots must be distributed evenly over the sample area.

   Of the portion of sample plots stocked with conditional established seedlings, the amount of deciduous and/or fir plots must not exceed 10%.

2.1.2 Mixedwood Standard

The Establishment Survey must be carried out 4 to 8 years after harvesting.

Under these reforestation standards, a mixedwood stocking standard (DC standard) may be applied. In order to apply the DC standard, the following guidelines will be used:

a. The stand must be predominantly deciduous, but still contain a merchantable coniferous volume. Acceptable deciduous species are trembling aspen (Aw), white birch (Bw) and balsam poplar (Pb). If the merchantable coniferous volume is greater than 50 m3/ha but less than 100 m3/ha and the merchantable deciduous volume is greater than the coniferous volume, then this stand can be designated DC and reforested to the mixedwood standard.

b. In order to apply the DC standard, the stand must be assessed prior to harvest and approved by the Forest Superintendent. The

DC designation will be recorded in the annual operating plan. Any procedures used to gather information in order to apply the DC standard must also be approved by the Forest Superintendent.

c. The DC designation may be established and cutblocks stratified as follows:

   (1) from good quality aerial photography of not less than 1:20 000 scale that is no more than five years older than the year of assessment; *or*

   (2) through an approved aerial reconnaissance of the stand; *or*

   (3) through submission of an approved timber cruise of the stand.

d. Cutblocks may be stratified such that a portion of the total cutblock area may be designated DC. Any portion must not be less than 4 ha in size and there can be no more than three stratified areas (portions) per cutblock. If the DC designation is applied to a portion of a cutblock, that portion will be considered a separate block.

e. Refer to Forest Service circular R14 for further details on the application of the DC standard.

Acceptable established seedlings and conditional established seedlings in the mixedwood standard are the same as those defined in subsection 2.1.1 (Coniferous Standard) and the minimum height requirements are the same as shown in Tables 2.1 and 2.2.

Stocking

The basic sampling unit is considered stocked if it contains at least one acceptable established seedling, as outlined in Table 2.1.

A harvested mixedwood area will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least one acceptable established seedling (Table 2.1). The stocked plots must be distributed evenly over the sample area; *or*

b. 45% of the sample plots are stocked with at least one acceptable established seedling (Table 2.1), and an additional 35% of the

sample plots are stocked with at least one conditional established seedling (Table 2.2). The stocked plots must be distributed evenly over the sample area.

Of the portion of sample plots stocked with conditional established seedlings, the deciduous and/or fir plots must not exceed 30%. The portion of spruce or pine plots (including larch and Douglas-fir) must not exceed 5%.

2.1.3 Deciduous Standard

The Establishment Survey must be carried out at least 3 years, but no later than 5 years, after harvesting.

Table 2.3 details the requirements for acceptable established seedlings on areas harvested primarily for deciduous timber. The seedlings must be live, healthy and undamaged, and have grown on-site for a minimum of three years.

TABLE 2.3

Acceptable established seedlings for an area harvested primarily for deciduous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
Trembling aspen	150
Balsam poplar	150
White birch	150

An acceptable established seedling may also consist of a live **spruce, pine, larch, Douglas-fir, aspen, poplar** or **birch** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the following characteristics:

a. The tree shows good health and vigour, is undamaged, and will probably be alive and merchantable when the rest of the established trees are harvested.

b. The tree has a well-defined stem. Trees with multiple stems (more than two multiple stems at base) may not be recorded as

established seedlings. Trees with more than three multiple lateral shoots not at the base may not be recorded as established seedlings.

c. The tree originated from seed rather than from layering (in deciduous species, suckering is accepted in this category).

d. The crown covers two-thirds or more of the tree height and appears to be normal in form for the species. The crown cover requirement does not apply to deciduous trees.

A live **fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the characteristics outlined above, may be considered a **conditional** established seedling.

Acceptable and conditional advanced growth must meet the minimum height requirements as set out in Tables 2.3 and 2.4.

Stocking

The basic sampling unit is considered stocked if it contains at least **three** acceptable established deciduous seedlings (only one required if hybrid poplar) as outlined in Table 2.3, or one conditional coniferous seedling as outlined in Table 2.4.

TABLE 2.4

Conditional established seedlings for an area harvested primarily for deciduous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
Balsam fir	40
Alpine fir	40
White spruce	40
Engelmann spruce	40
Black spruce	40
Lodgepole pine	75
Jack pine	75
Whitebark pine	75
Limber pine	75
Larch (all species)	75
Douglas-fir	40

An area harvested for deciduous timber will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least three acceptable (Table 2.3) or at least one conditional (Table 2.4) established seedling. The stocked plots must be distributed evenly over the sample area.

2.2 Performance Survey

2.2.1 Coniferous Standard

The Performance Survey must be carried out 8 to 14 years after harvesting. Table 2.5 details the requirements for an acceptable established sapling on areas harvested primarily for coniferous timber.

An acceptable established sapling is a specific tree species that has reached a standardized height requirement, is alive, healthy and undamaged.

TABLE 2.5

Acceptable established saplings for an area harvested primarily for coniferous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
White spruce	150
Engelmann spruce	150
Black spruce	150
Lodgepole pine	200
Jack pine	200
Whitebark pine	200
Limber pine	200
Larch (all species)	200
Douglas-fir	150

An acceptable established sapling may also consist of a live **spruce, pine, larch** or **Douglas-fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the following characteristics:

a. The tree shows good health and vigour, is undamaged, and will probably be alive and merchantable when the rest of the established trees are harvested.

b. The tree has a well-defined stem. Trees with multiple stems (more than two multiple stems at base) may not be recorded as established saplings. Trees with more than three multiple lateral shoots not at the base may not be recorded as established seedlings.

c. The tree originated from seed rather than from layering (in deciduous species, suckering is accepted in this category).

d. The crown covers two-thirds or more of the tree height and appears to be normal in form for the species. The crown cover requirement does not apply to deciduous trees.

A live **aspen, poplar, birch** or **fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the characteristics outlined above, may be considered a **conditional** established sapling.

Acceptable and conditional advanced growth must meet the minimum height requirements as set out in Tables 2.5 and 2.6.

TABLE 2.6

Conditional established saplings for an area harvested primarily for coniferous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
All spruce species/Douglas-fir	100
All pine species/Larch species	150
Balsam fir	150
Alpine fir	150
Trembling aspen	200
Balsam poplar	200
White birch	200

Stocking

The basic sampling unit is considered stocked if it contains at least one acceptable established sapling that is Free To Grow, as outlined in Table 2.5.

A sapling (crop tree) is considered Free to Grow if there are no deciduous trees that are equal to or taller than two-thirds of the height of the crop tree within a 1-m radius of the crop tree measured stem to stem.

Deciduous trees remaining from the previous rotation will not be considered as competition in the Free-To-Grow assessment.

An area harvested primarily for coniferous timber will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least one acceptable established sapling (Table 2.5) that is Free To Grow. The stocked plots must be distributed evenly over the sample area; *or*

b. 60% of the sample plots are stocked with at least one acceptable established sapling (Table 2.5) that is Free To Grow, and an additional 20% of the sample plots are stocked with conditional established saplings (Table 2.6). Conditional established coniferous saplings must be Free to Grow and the stocked plots must be distributed evenly over the sample area.

   Of the portion of sample plots stocked with conditional established saplings, the number of deciduous and/or fir plots must not exceed 10%.

2.2.2 Mixedwood Standard

The Performance Survey must be carried out 8 to 14 years after harvesting.

On cover types designated as deciduous-coniferous (DC), a mixedwood stocking standard (DC standard) may be applied. The DC standard will have already been applied prior to harvest, subject to the guidelines set out in the Establishment Survey section (2.1) of this manual (see subsection 2.1.2, Mixedwood Standard). The DC designation will have been recorded in the annual operating plan.

Acceptable established saplings and conditional established saplings in the mixedwood standard are the same as those defined in subsection 2.2.1 (Coniferous Standard) and the minimum height requirements are the same as shown in Tables 2.5 and 2.6.

Stocking

The basic sampling unit is considered stocked if it contains at least one acceptable established sapling that is Free to Grow as outlined in Table 2.5.

A sapling (crop tree) is considered Free to Grow if there are no deciduous trees that are equal to or taller than two-thirds of the height of the crop tree within a 1-m radius of the crop tree measured stem to stem.

Deciduous trees remaining from the previous rotation will not be considered as competition in Free-To-Grow assessment.

A harvested deciduous-coniferous area will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least one acceptable established sapling (Table 2.5) that is Free To Grow. The stocked plots must be distributed evenly over the sample area; *or*

b. 45% of the sample plots are stocked with at least one acceptable established sapling (Table 2.5) that is Free To Grow, and an additional 35% of the sample plots are stocked with conditional established saplings (Table 2.6). Conditional established coniferous saplings must be Free to Grow and the stocked plots must be distributed evenly over the sample area.

   Of the portion of sample plots stocked with conditional established saplings, the number of deciduous and/or fir plots must not exceed 30%. The portion of spruce or pine plots (including larch and Douglas-fir) must not exceed 5%.

2.2.3 Deciduous Standard

There is no deciduous standard in the Performance Survey.

2.3 High Elevation and Lowland Modifier

2.3.1 High Elevation Modifier

For elevations higher than 1500 metres above sea level, the following height or age standard applies:

a. the minimum crop tree height shall be 75% of the height standard for acceptable and conditional established seedlings and saplings, as defined in Tables 2.1 and 2.2 for Establishment Surveys or Tables 2.5 and 2.6 for Performance Surveys; *or*

b. the minimum age for acceptable and conditional seedlings or saplings shall be

   (1) six years of age after harvest in the Establishment Survey, *or*

   (2) 12 years of age after harvest in the Performance Survey.

If the High Elevation Modifier is applied, the area harvested will be considered satisfactorily restocked when:

a. 70% or more of the sample plots are stocked with at least one acceptable established seedling or sapling (Tables 2.1 or 2.5). The stocked plots must be distributed evenly over the sample area. The acceptable established sapling must also be Free To Grow; *or*

b. 60% of the sample plots are stocked with at least one acceptable established seedling or sapling (Tables 2.1 or 2.5) and an additional 10% of the sample plots are stocked with conditional established seedlings or saplings (Tables 2.2 or 2.6). The stocked plots must be distributed evenly over the sample area. Acceptable and conditional established saplings must also be Free To Grow.

   The High Elevation Modifier can only be applied to a whole cutblock and must be designated in the annual operating plan prior to harvest. At least 50% or more of the cutblock must be above the 1500 metre (ASL) contour for this modifier to apply.

2.3.2 Lowland Modifier

The Lowland Modifier can be applied to areas defined in the following manner:

a. In the Phase 3 Inventory, areas that are defined as pure spruce (Sb, Sw) with a site index less than or equal to 10.5 (f) for white spruce and less than or equal to 6.0 (f) for black spruce qualify for the modifier. These areas should be delineated on aerial photographs at no less than 1:20 000 scale, no older than five years before the year of assessment. These areas can also be delineated on the Phase 3 map.

b. Individual plots in the survey can be designated as modified plots if the organic layer at the plot center is greater than 60 cm thick.

The following height and age standard applies when using the Lowland Modifier:

a. the minimum crop tree height shall be 75% of the height standard for acceptable and conditional established seedlings and saplings as defined in Tables 2.1 and 2.2 for Establishment Surveys or Tables 2.5 and 2.6 for Performance Surveys; *or*

b. the minimum age for acceptable and conditional seedlings or saplings shall be:

   (1) six years of age after harvest in the Establishment Survey, *or*

   (2) 12 years of age after harvest in the Performance Survey.

If the Lowland Modifier is applied to a cutblock, the area harvested will be considered satisfactorily restocked when:

a. 70% or more of the sample plots are stocked with at least one acceptable coniferous seedling or sapling (Tables 2.1 or 2.5). The stocked plots must be distributed evenly over the sample area. The acceptable established sapling must also be Free To Grow; *or*

b. 60% of the sample plots are stocked with at least one acceptable seedling or sapling (Tables 2.1 or 2.5) and an additional 10% of the sample plots are stocked with conditional established seedlings or saplings (Tables 2.2 or 2.6). The stocked plots must be

distributed evenly over the sample area. Acceptable and conditional established saplings must also be Free To Grow.

The Lowland Modifier must be designated in the annual operating plan if applied to a whole cutblock. The Lowland Modifier can still be applied on a per-plot basis as described previously but the reduced stocking percentage requirement would not be in effect.

2.4 Cutblocks Harvested Prior to March 1, 1991

The stocking standards previously described in the Alberta Forest Service Regeneration Survey Manual, April 1979, shall apply to cutblocks harvested prior to March 1, 1991. These stocking standards are described in this section. Although the old standard still applies to cutblocks harvested **prior to March 1, 1991**, the actual survey procedure described in this manual applies to all regeneration surveys done in either standard.

Density estimates and associated height measurements must also be collected as outlined for Establishment Surveys in Sections 2.1 (Establishment Survey) and 3.4.6 (Tally Cards) of this manual.

2.4.1 Coniferous Standard

Table 2.7 details the requirements for an acceptable established seedling in areas harvested primarily for coniferous timber prior to March 1, 1991.

An established seedling is defined as follows:

a. a live, healthy and undamaged pine seedling that has grown on-site for a minimum of two years; *or*

b. a live, healthy and undamaged spruce, fir, Douglas-fir, larch, birch, aspen or poplar seedling that has grown on-site for a minimum of three years; *or*

c. two live, healthy and undamaged seedlings, other than pine, that have grown on-site for a minimum of two years.

TABLE 2.7

Acceptable established seedlings for an area harvested prior to March 1, 1991, primarily for coniferous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
White spruce	3
Engelmann spruce	3
Black spruce	3
Lodgepole pine	2
Jack pine	2
Whitebark pine	2
Limber pine	2
Larch (all species)	3
Douglas-fir	3

An acceptable established seedling may also consist of a live **spruce, pine, larch** or **Douglas-fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the following characteristics:

a. The tree shows good health and vigour, is undamaged, and will probably be alive and merchantable when the rest of the established trees are harvested.

b. The tree has a well-defined stem. Trees with multiple stems (more than two multiple stems at base) may not be recorded as established seedlings. Trees with more than three multiple lateral shoots not at the base may not be recorded as established seedlings.

c. The tree originated from seed rather than from layering (in deciduous species, suckering is accepted in this category).

d. The crown covers two-thirds or more of the tree height and appears to be normal in form for the species.

A live **aspen, poplar, birch** or **fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the characteristics outlined above, may be considered a **conditional** seedling.

Stocking

The basic sampling unit is considered stocked if it contains at least one acceptable established seedling, as outlined in Table 2.7.

An area harvested primarily for coniferous timber will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least one acceptable established seedling (Table 2.7), and the stocked plots are distributed evenly over the sample area; *or*

b. 60% of the sample plots are stocked with at least one acceptable established seedling (Table 2.7), and an additional 20% of the sample plots are stocked with at least one conditional established seedling (Table 2.8). The stocked plots must be distributed evenly over the sample area.

TABLE 2.8

Conditional established seedlings for an area harvested prior to March 1, 1991, primarily for coniferous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
Balsam fir	3
Alpine fir	3
Trembling aspen	3
Balsam poplar	3
White birch	3

2.4.1.1 Age Determination

For the purpose of determining age, the following guide is to be used. A seedling planted before *June 20* in any one year, or a seedling that has germinated from seed before that date, shall be considered to have grown one full growing season on site by the end of that year. Such seedlings may be regeneration surveyed for establishment after *August 1* in the second year in the case of pine, and after *August 1* in the third year for all other species.

2.4.2 Deciduous Standard

Table 2.0 details the requirements for an acceptable established seedling for areas harvested primarily for deciduous timber prior to March 1, 1991.

TABLE 2.9

Acceptable established seedlings for an area harvested prior to March 1, 1991, primarily for deciduous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
Trembling aspen	3
Balsam poplar	3
White birch	3
White spruce	3
Engelmann spruce	3
Black spruce	3
Lodgepole pine	2
Jack pine	2
Whitebark pine	2
Limber pine	2
Larch (all species)	3
Douglas-fir	3

An acceptable established seedling may also consist of a live **spruce, pine, larch, Douglas-fir, aspen, poplar** or **birch** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the following characteristics:

a. The tree shows good health and vigour, is undamaged, and will probably be alive and merchantable when the rest of the established trees are harvested.

b. The tree has a well-defined stem. Trees with multiple stems (more than two multiple stems at base) may not be recorded as established seedlings. Trees with more than three multiple lateral shoots not at the base may not be recorded as established seedlings.

c. The tree originated from seed rather than from layering (in deciduous species, suckering is accepted in this category).

d. The crown covers two-thirds or more of the tree height and appears to be normal in form for the species. The crown cover requirement does not apply to deciduous trees.

A live **fir** tree that grew on-site and still remains after logging (commonly called **advanced growth**), and which has the characteristics outlined above, may be considered a **conditional** established seedling.

Stocking

The basic sampling unit is considered stocked if it contains at least one acceptable established seedling, as outlined in Table 2.9.

An area harvested primarily for deciduous timber will be considered satisfactorily restocked when:

a. 80% or more of the sample plots are stocked with at least one acceptable established seedling (Table 2.9), and the stocked plots are distributed evenly over the sample area; *or*

b. 60% of the sample plots are stocked with at least one acceptable established seedling (Table 2.9), and an additional 20% of the sample plots are stocked with at least one conditional established balsam fir or alpine fir (Table 2.10). The stocked plots must be distributed evenly over the sample area.

TABLE 2.10

Conditional established seedlings for an area harvested prior to March 1, 1991, primarily for deciduous timber.

SPECIES	MIN CROP TREE HEIGHT (cm)
Balsam fir	3
Alpine fir	3

2.4.2.1 Age Determination

For the purpose of determining age, the following guide is to be used. A seedling planted before *June 20* in any one year, or a seedling that has germinated from seed before that date, shall be considered to have grown one full growing season on site by the end of that year. Such seedlings may be regeneration surveyed for establishment after *August 1* in the second year in the case of pine, and after *August 1* in the third year for all other species.

2.5 Extra Data

When surveying cutblocks harvested after March 1, 1991 it is recommended that an age be taken of the crop tree. This data will be used to generate site index curves. Conversely, for the same reasons given above, it is recommended that the height of the crop tree be recorded when applying the old standard. Also, age estimates, as precise as possible, should be recorded when using the old standard. The past practice of recording the minimum age to pass the standard (ie: 3+, 2+) is discouraged.

3.0 FIELD SURVEY PROCEDURES

A systematic survey must be used to determine the amount and location of stocking on all areas where seedling distribution is or can be considered random.

3.1 Statistical Accuracy Standards

The systematic survey method has been designed to satisfy the statistical accuracy standards outlined in Table 3.1. The error levels are inherent in the survey system and do not include error on the part of the surveyor. Accuracy will be further reduced if human error, either by omission or commission, is introduced into the sampling.

The sampling error for an individual block can be calculated using the formula:

$$E = \pm 200 \sqrt{\frac{p \times q}{n}}$$

Where:
- E = sampling error in percent.
- p = proportion of stocked plots expressed as a decimal, e.g., 70% = 0.70.
- q = 1 - p; proportion of plots unstocked expressed as a decimal, e.g., 1.00 - 0.70 = 0.30.
- n = number of sample plots established.

3.2 Number of Sample Plots Required

The total number of plots required to sample any given area can be calculated using the formula:

$$n = 40{,}000 \frac{p \times q}{E^2}$$

Where:
- n = number of sample plots to be established.
- p = proportion of plots stocked expressed as a decimal.
- q = 1 - p; proportion of plots unstocked expressed as a decimal.
- E = maximum allowable sampling error, which must not exceed:
  - ±10.0% for blocks larger than 4 ha, or
  - ±12.5% for blocks 2-4 ha where the stocking result indicated by the survey is 80% or more.

The values of p and q are not known for the area prior to the survey, so an assumed stocking value of 80% is to be used.

The number of plots required within the various sizes of cutblocks is shown in Table 3.1. The decision to use a constant sampling intensity on cutblocks larger than 24 ha is based on the management decision that SR/NSR areas larger than 4 ha are to be delineated.

TABLE 3.1

Sampling requirements for Establishment and Performance surveys.

A. Statistical Accuracy Standards:

BLOCK SIZE (HA)	STATISTICAL ACCURACY
0 - 1.9	Variable
2 - 4	Within ± 12.5% with 95% confidence when stocking is 80% or greater.
4+	Within ± 10.0% with 95% confidence when stocking is 80% or greater.

B. Number of Sample Plots Required:

BLOCK SIZE (HA)	NUMBER OF PLOTS
0 - 1.9	Min. 12.4 plots/ha
2 - 4	Establish min. 41 plots/block or as many as needed to cover block. If stocking in 73%-79% range, intensify to 54 plots.
4.1 - 24	Establish min. 64 plots/block or as many as needed to cover block. If stocking in 73%-79% range, intensify to 84 plots.
24+	2.77 plots/ha

3.3 Calculation of Survey Grid

Once the total number of plots and the area of the block are known, the survey grid (plot and line spacing) can be calculated. The procedure involves three steps:

Step 1: Calculate the sampling intensity

$$S_i = \frac{n}{\text{block area}}$$

where: S_i = sampling intensity
n = required number of sample plots

Step 2: Calculate the area represented by one sample plot in square metres, as follows:

$$\frac{1}{S_i} \times 10{,}000^*$$

*multiply by 10 000 because 10 000 m^2 = 1 ha

Step 3: Calculate line and plot spacing (i.e., survey grid):

Line spacing x plot spacing = area represented by one sample plot.
= survey grid

The square root of the area represented by one sample plot indicates the line and plot spacing in a square layout. Often it is desirable to design field sampling in a rectangular pattern. In such a case, one side of the rectangle, usually the line spacing, has to be arbitrarily selected. The other side of the rectangle or plot spacing will have to be calculated. The only limitation on rectangular sampling design is that the distance between survey lines must not be greater than twice the distance between plots along the lines. For blocks 24 ha and larger, a 60 m x 60 m grid must be used.

Example: For a survey on a 12.1 ha block, calculate a square survey grid and a rectangular survey grid.

For the rectangular grid, assume a line spacing of 40 m.

Step 1: Sampling intensity $(S_i) = \frac{64 \text{ plots}}{12.1 \text{ ha}} = 5.29$ plots/ha

Step 2: Area represented by one plot

$= \frac{1}{5.29} \times 10{,}000 = 1890.36 \text{ m}^2$

Step 3: a. Square survey grid:

line spacing x plot spacing = 1890.36 m^2

line spacing = $\sqrt{1890.36 m^2}$

line spacing = 43.48 m
plot spacing = 43.48 m

Therefore, the grid is 43.48 m x 43.48 m

b. Rectangular survey grid:

line spacing x plot spacing = 1890.36 m^2
40 m x plot spacing = 1890.36 m^2
plot spacing = 1890.36 m^2 = 47.26m

Therefore, the grid is 40.00 m x 47.26 m

3.4.1 Control Lines

For each area to be surveyed, the control line(s) should be established for control of plot location as follows:

a. Establish one control line that is parallel to the long axis of the block. Where the block width exceeds 400 m, establish additional lines parallel to the first at 400-m intervals. On scarified areas, establish the control line(s) parallel to the strips and/or windrows. Preferably, the control line(s) should be placed in such a location as to be useable for plot establishment.

b. The control line(s) should be referenced to the cutblock boundary at a minimum of two points in order to be able to map the sample plot locations accurately. When setting up the position of the control line, the survey grid must be centred in the cutblock. To do this, move out one-half the interplot distance away from the cutblock boundary and measure along the ground to the point where the control line will be located. If the survey grid is rectangular, either move out from the cutblock boundary one-half the interplot or one-half the interline distance, depending on the direction of travel and the point at which the cutblock was entered (see Figure 3.1).

   If the cutblock was entered at a point in the middle, and the control line will be started at that same point, move out from the cutblock boundary one-half the interline distance and proceed to lay out the control line.

c. Survey line intervals are to be clearly marked when establishing the control line(s).

3.4.2 Survey Lines

a. Survey lines are to be run perpendicular to the control lines, parallel with each other and at a calculated spacing.

b. Establish the first survey line at half of the prescribed line spacing from the edge of the cutblock. This is in keeping with the concept presented in subsection 3.4.1b (see also Figure 3.1).

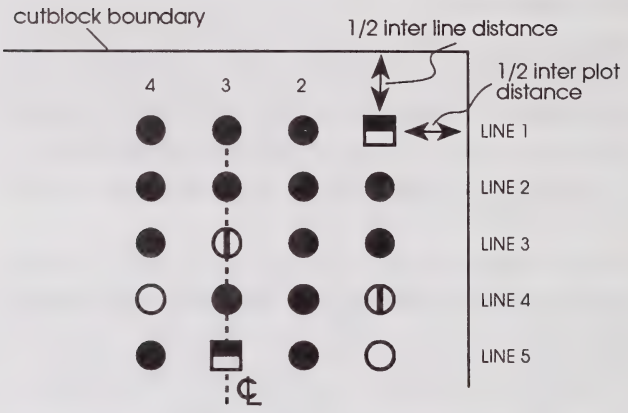


Figure 3.1 Illustration of plot layout and centering grid.

c. All survey and control lines are to be chained and compassed. All measured distances must be based on horizontal or surface projections.

d. The number of each survey line must be written on geoflagging at every plot.

3.4.3 Plot Layout

a. The size of the sample plot shall be 1/1000 ha or 10 m^2.

b. The shape of the sample plot shall be circular and have a radius of 1.78 m; the centre of the circle and the plot centre shall be a common point.

c. Every plot must be numbered in order to facilitate field checking and plot identification at the time of treatment. Numbering should be continuous.

d. Every plot centre is to be clearly marked in the field. Mark plot centres with a stake and geoflagging as follows:

> Take a 0.5 m stick from local slash and implant it firmly at the plot centre. Write the plot number and line number on a piece of geoflagging with a black, waterproof marker pen and then attach the geoflagging to the stick. Do not use grass, herbs or shrubs to indicate plot centres.

e. Acceptable established seedling/saplings and conditional established seedling/saplings must be marked with geoflagging in every plot to facilitate field checking.

3.4.4 Plot Deletions/Moving Plots

Plots falling on uncut patches 0.4 ha or larger, or on water holes 0.04 ha or larger, must be deleted. If a plot falls within a right-of-way, haul road or on an area that has dispositions for mineral rights (including seismic lines), it must be moved half the grid distance between the plots. If this does not move the plot off the disposition area, move another half-plot distance. If one plot is moved from its normal location, the plot that follows should still be located at its normal, predetermined location to simplify mapping.

If a plot is deleted, it must be made up elsewhere in the cutblock so the minimum number of active plots required is met, depending on the size of the cutblock or the type of survey.

Plots falling on brush piles, skid roads or abandoned campsites are not to be deleted or moved.

3.4.5 Adding Plots

The minimum number of plots must be established (see Table 3.1). If additional plots are required to make up this minimum number, they should be spaced as follows:

a. Halfway between every third survey line (i.e., halfway between the parallel third and fourth survey lines, sixth and seventh lines, etc.).

b. Plot spacing should be the same on the additional lines as on the original lines to facilitate delineation of SR/NSR areas.

c. If the cutblock area is exceeded while adding plots as described above, proceed back across the cutblock, adding plots between survey lines that have no additional plots until the desired number of plots is reached.

3.4.6 Tally Cards

Regeneration survey data shall be recorded for each plot on the RR141, RR141A and RR138A regeneration survey forms. In addition, all information appearing on these forms is to be summarized on the RR144J or RR144K Silvicultural Record Management System forms which are available at the Reforestation Branch of the Alberta Forest Service in Edmonton or at any forest headquarters. On the back of these forms is a grid on which a final map of the cutblock, complete with species symbols and other relevant information, is to be drawn. Species symbols and abbreviations to be used are found in Appendix 4 and also on 32 of this manual.

Data to collect:

a. Establishment Surveys:

Stocking Information

(1) Species and height of acceptable established seedling(s) (height to the nearest cm).

(2) Species and height of conditional established seedling(s) (height to the nearest cm), if no acceptable established seedlings present.

(3) Species and height of advance growth (height to the nearest 10 cm; if greater than 300 cm, record as 300+).

Density Information

(1) Number of all the trees in the plot that are greater than or equal to 30 cm in height (if number is greater than 10 trees/ plot, use estimate). This information shall be recorded by tree species group. The crop tree that was measured must also be included in the count, in the species group that it falls into.

(2) Estimate of the mean height of the most frequently occurring height class of trees in the plot, by species group, that are greater than or equal to 30 cm in height.

Damage Information

(1) Obvious damage resulting from insects or disease. Damage information could also include any fire damage to the seedlings observed. This can be recorded in the box labelled "Other". Also, attempt to estimate the percentage of the cutblock that is affected by the damage, or keep track of the damage on a per-plot basis until the survey is completed. Supplementary information on damage to the crop trees that has occurred in the cutblock can also be recorded in the "Comments" section of the tally sheet.

b. Performance Surveys:

Stocking Information

(1) Species and height of acceptable established sapling (height to the nearest cm).

(2) Species and height of conditional established sapling (height to the nearest cm), if no acceptable established sapling present.

(3) Species and height of advance growth (height to the nearest 10 cm; if greater than 300 cm, record as 300+).

Free-to-Grow Information

(1) Height and species of the tallest deciduous tree over 30 cm within a 1-m radius of the acceptable established sapling or conditional established sapling. This information is to be recorded regardless of whether or not the crop tree is Free-To Grow.

Density Information

(1) Number of all the trees in the plot that are greater than or equal to 30 cm in height (if more than 10 trees/plot, use estimate). This information shall be recorded by tree species group.

(2) Estimate of the mean height of the most frequently occurring height class of trees in the plot, by species group, that are greater than or equal to 30 cm in height.

Damage Information

(1) Obvious damage resulting from insects or disease. Damage information could also include any fire damage to the saplings observed. This can be recorded in the box labelled "Other". Also, attempt to estimate the percentage of the cutblock that is affected by the damage, or keep track of the damage on a per-plot basis until the survey is completed. Supplementary information on damage to the crop trees that has occurred in the cutblock can also be recorded in the "Comments" section of the tally sheet.

3.4.6.1 Density and Height Collection

The frequency of collection of density and associated height estimate data within the establishment survey will depend on the year since the cutblock has been treated. The following table shows the guideline to be followed:

YEARS SINCE TREATMENT	COLLECTION PLOTS
3	no collection
4	every third plot
5	every third plot
6	every third plot
7	every plot
8	every plot

In the performance survey, density and associated height data is to be collected on all plots.

3.4.7 Mapping

Field maps should be drawn on the back of form RR138A as the survey progresses through the cutblock. This will help the surveyor map certain features of the cutblock or status of the plots surveyed to be used for later reference. The final map to be submitted to the Forest Service must be drawn on the back of form RR144J or RR144K, depending on the type of survey done. All maps submitted are to show the following information for each block surveyed:

a. Location: licences or permits and cut unit number. (If not applicable, use legal description and project number.)

b. Cutblock boundaries.

c. Total block area. Use survey grid to check on block area. Make corrections where necessary. (Applies only to those surveys done in horizontal projections.)

d. North arrow.

e. Location of control line(s) and tie point(s) for same.

f. Location of survey lines and plots.

g. Plot number.

h. The location and extent of permanent deletions.

i. Stocking status and species grouping for each plot (see symbols below):

- non-stocked
- stocked with acceptable coniferous; not Free-to-Grow
- stocked with acceptable deciduous
- stocked with alpine or balsam fir
- not cut or deleted plot
- stocked with conditional coniferous (not Fa, Fb); not Free-to-Grow
- stocked with conditional deciduous
- stocked with acceptable coniferous; Free-to-Grow
- stocked with conditional coniferous (not Fa, Fb); Free-to-Grow
- converted to Fa or Fb plot
- converted conditional deciduous plot
- converted conditional coniferous plot
- underaged or undersized seedlings/saplings

If recording an underaged or undersized seedling/sapling using the above symbol, and if there is also a healthy deciduous/fir crop tree in the plot that would allow the plot to be used as a conditional plot in the total stocking calculation, then mark an "X" inside the box. This information must also be recorded on the tally sheet. Record the undersized/underaged seedling by species in the "Acceptable Species" column, then circle it. Record the conditional species in the appropriate column. Split the box in the "Height" column and record the height of both crop trees tallied.

4.0 OFFICE COMPILATION

4.1 Procedure

a. Transfer all information from field tally cards and field maps onto forms RR144J and RR144K. On the back of these forms is a map scale for drawing a map of the cutblock. Select a reasonable scale with which you can reproduce a neat, detailed drawing of the cutblock. Ensure that all information required, as outlined in section 3.4.7 of this manual, is on the map.

b. For coniferous and mixedwood cutblocks, determine which plots do not meet the requirements for acceptable established seedlings but do meet the requirements for conditional established seedlings, and which may be converted to acceptable plots for mapping and stocking percentage calculations, as follows:

   (1) Coniferous survey - when 20% or less of the total usable plots in the sample ("n") are stocked with conditional established seedlings or saplings, the plots may be converted to acceptable plots as follows:

      (a) the maximum number of plots stocked with conditional coniferous seedlings or saplings must not exceed 20% of "n";

(b) the maximum number of plots stocked with conditional deciduous/fir seedlings or saplings must not exceed 10% of "n".

If the total number of conditional deciduous/fir plots exceeds 10% of "n", the plots to be converted must be calculated using the following formula:

$$\frac{\text{\# of plots cond. decid./fir}}{0.1 \times n}$$

If the number of conditional coniferous plots exceeds 20% of "n", the plots to be converted must be calculated using the following formula:

$$\frac{\text{\# of plots cond. conif.}}{0.2 \times n}$$

If the number of conditional coniferous plots exceeds 10% of "n", then the number of conditional deciduous/fir plots that can be converted must be reduced accordingly in order not to drive the total of conditional plots converted over 20% of "n". A maximum of 20% of the conditional coniferous plots may be converted, but only 10% of the conditional deciduous/fir plots.

For example, if the number of conditional coniferous plots was 15% of "n", and these were all converted, and the total number of deciduous/fir plots was 10% of "n", then a maximum of 5% of the remaining deciduous/fir plots could be converted, thereby making the total of all conditional plots converted 20%. If the total number of conditional deciduous/fir plots exceeded the allowable percentage of plots that could be converted, as in this example, the deciduous/fir plots to be converted would have to be calculated using the above formula. The formula for this example would be:

$$\frac{\text{\# of plots decid./fir}}{0.05 \times n}$$

(2) mixedwood survey - when 35% or less of the total usable plots in the sample ("n") are stocked with conditional established seedlings or saplings, these plots may be converted to acceptable plots as follows:

(a) the maximum number of plots stocked with conditional deciduous/fir seedlings or saplings must not exceed 30% of "n";

(b) the maximum number of plots stocked with conditional coniferous seedlings or saplings must not exceed 5% of "n".

If the total number of conditional deciduous/fir plots exceeds 30% of "n", the plots to be converted must be calculated using the following formula:

$$\frac{\text{\# of plots cond. decid./fir}}{0.3 \times n}$$

If the number of conditional coniferous plots exceeds 5% of "n", the plots to be converted must be calculated using the following formula:

$$\frac{\text{\# of plots cond. conif.}}{0.05 \times n}$$

The formulas given in the previous explanations have the following basic form:

$$\frac{\text{\# of plots conditional}}{(\text{allowable percentage}) \times n}$$

This formula will always yield a number defining which plots to convert. The numbers used in this formula will vary depending on the category of survey being used.

For example, if a coniferous survey yielded the following data:

n = 64

Cond. decid/fir - 16% of "n" (10 plots)

the conditional decid/fir plots to convert would be determined as follows:

$$\frac{10 \text{ plots cond. decid./fir}}{.1 \times 64} = 1.6$$

Round off 1.6 to the next highest whole number, which is 2 in this case. Therefore, the formula has calculated every second conditional deciduous/fir plot should be converted.

The above example procedure should be used for all categories of conditional plots described previously.

When converting plots, do not treat individual survey lines separately, but assume one continuous survey line in the direction of travel on the block, starting with the first plot. Mark the converted plots on the map by drawing a circle around the original plot symbol.

When rounding up using the above formula, there may be insufficient plots to convert in the cutblock. In this situation, return to the first conditional plot in the survey grid and repeat the same pattern with the next unconverted conditional plot until conversion has occurred on the maximum number of plots allowed by the standard. This procedure prevents the loss of any potential stocking percentage gained by converting conditional plots.

c. Visually check the distribution of stocked and/or unstocked plots. If the distribution is even, accept the calculated value as the final percentage for the block. If the distribution is uneven, delineate the SR/NSR patches using the following guidelines:

(1) Identifying unstocked areas within a generally stocked cutblock:

(a) Starting at one corner of the block, proceed along the lines and examine five plots at a time. After the first five plots have been examined, drop the first plot in the line

and add one plot on the end (running average of five plots). Continue progressing to the end of the line until the last five plots have been checked.

(b) A section of five plots is called stocked if four of the plots are stocked. A section of five plots is called unstocked if it contains zero to three stocked plots. Five is considered the optimum number because four out of five stocked plots coincides with 80% stocking. If there are fewer than five plots in a line, all plots must be stocked in order to call the whole line stocked. This method of determination is called a "moving average". If there are more than five plots in a line, the beginning of the first unstocked five-plot section and the end of the last unstocked five-plot section should be marked to cut out the unstocked portion of a line (see Appendix 2).

(c) After each line is checked and marked, the marked areas should be joined to show the boundaries of the suspected unstocked areas. The same procedure is to be repeated by running the five-plot, moving average across the lines. An area shown to be NSR in both directions shall be considered part of the NSR area requiring treatment.

(2) Identifying stocked areas within a generally unstocked block:

The procedure is the same as for identifying unstocked areas in a stocked block, except a five plot section is considered stocked only when all the plots are stocked. This means 100% stocking. The procedure described above should not be used to delineate SR/NSR patches that are 4 ha or smaller, and there should be a minimum of 10 plots in the subunit. This restriction is necessary because if the number of plots is very small, there is a high probability that the area will be classified incorrectly.

Some logical adjustments may be made around the border of the NSR area. When the above procedure has been completed, calculate the area of each NSR patch to determine if any of these is greater than 4 ha.

d. Calculate the overall stocking percentage for the cutblock once the relevant conditional plots have been converted.

e. Unstocked portions of stocked blocks, which will require reforestation treatment, must be shown on the final map that is submitted to the District Forest Office for approval.

f. When there are reasonable and probable grounds to suspect that an indicated NSR subunit within a generally satisfactorily stocked block is actually SR, the option is open to establish additional survey plots in the subunit to obtain a 10% sampling error in lieu of treatment. Should the resultant stocking percentage still be less than 80%, the area will require reforestation treatment.

4.2 Compilation of Density Information

a. Calculate the density/species/hectares for each block. A suggested formula for this purpose is:

$$\#\ \text{stems/ha.} = \frac{\text{Avg. \# stems/plot}}{0.001}$$

When calculating the average number of stems per plot, make sure to include those plots encountered with no trees on them at all.

b. Calculate the mean height/species group. Do not include those plots encountered that had no trees.

5.0 SURVEY SUBMISSION

Forest industry surveys must be submitted to the Alberta Forest Service by April 30 of the year in which they are due. An acceptable submission for each cutblock contains:

a. tally sheets and final map with delineation of NSR patches greater than 4 ha. These should be contained in one package, which includes forms RR141, RR141A, RR138A and the summary form RR144J or RR144K.

b. stocking percentages; can be shown on the back of form RR141 and on the final map (form RR144J or RR144K).

c. density and mean height information per species group.

d. plots that are converted.

e. all information as described in subsection 3.4.7.

APPENDIX 1

BLOCK SIZE:		SAMPLE:
0.0 – 1.9 ha	- - - - - - - - - - ►	min. 12.4 plots/ha
2.0 – 4.0 ha	- - - - - - - - - - ►	initially 41 plots/block
54 plots: If stocking 73% – 79%		41 plots: If stocking 0-72% *or* 80-100%
4.1 – 2.4 ha	- - - - - - - - - - ►	initially 64 plots/block
84 plots: If stocking 73% – 79%		64 plots: If stocking 0-72% *or* 80-100%
24.0 ha +	- - - - - - - - - - ►	min. 2.77 plots/ha

APPENDIX 2

Table A2.1

Survey Line and Sample Plot Spacing

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Allowable Error	Number of Plots
0.5	806.45	28.40	12.40	32.66	6
1.0	806.45	28.40	12.40	22.19	12
1.5	806.45	28.40	12.40	18.35	19
2.0	487.80	22.09	20.50	12.50	41
2.5	609.76	24.69	16.40	12.50	41
3.0	731.71	27.05	13.67	12.50	41
3.5	853.66	29.22	11.71	12.50	41
4.0	975.61	31.23	10.25	12.50	41
4.5	703.13	26.52	14.22	10.00	64
5.0	781.25	27.95	12.80	10.00	64
5.5	859.38	29.32	11.64	10.00	64
6.0	937.50	30.62	10.67	10.00	64
6.5	1015.63	31.87	9.85	10.00	64
7.0	1093.75	33.07	9.14	10.00	64

Survey Line and Sample Plot Spacing ... cont'd

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Allowable Error	Number of Plots
7.5	1171.88	34.23	8.53	10.00	64
8.0	1250.00	35.36	8.00	10.00	64
8.5	1328.13	36.44	7.53	10.00	64
9.0	1406.25	37.50	7.11	10.00	64
9.5	1484.38	38.53	6.74	10.00	64
10.0	1562.50	39.53	6.40	10.00	64
10.5	1640.63	40.50	6.10	10.00	64
11.0	1718.75	41.46	5.82	10.00	64
11.5	1796.88	42.39	5.57	10.00	64
12.0	1875.00	43.30	5.33	10.00	64
12.5	1953.15	44.19	5.12	10.00	64
13.0	2031.25	45.07	4.92	10.00	64
13.5	2109.38	45.93	4.74	10.00	64
14.0	2187.50	46.77	4.57	10.00	64
14.5	2265.63	47.60	4.41	10.00	64
15.0	2343.75	48.41	4.27	10.00	64
15.5	2421.88	49.21	4.13	10.00	64
16.0	2500.00	50.00	4.00	10.00	64
16.5	2578.13	50.78	3.88	10.00	64
17.0	2656.25	51.54	3.76	10.00	64
17.5	2734.38	52.29	3.66	10.00	64
18.0	2812.50	53.03	3.56	10.00	64
18.5	2890.63	53.76	3.46	10.00	64

Survey Line and Sample Plot Spacing ... cont'd

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Allowable Error	Number of Plots
19.0	2968.75	54.49	3.37	10.00	64
19.5	3046.88	55.20	3.28	10.00	64
20.0	3125.00	55.90	3.20	10.00	64
20.5	3203.13	56.60	3.12	10.00	64
21.0	3281.25	57.28	3.05	10.00	64
21.5	3359.38	57.96	2.98	10.00	64
22.0	3437.50	58.63	2.91	10.00	64
22.5	3515.63	59.29	2.84	10.00	64
23.0	3593.75	59.95	2.78	10.00	64
23.5	3671.88	60.60	2.72	10.00	64
24.0	3750.00	61.24	2.67	10.00	64
24.5	3610.11	60.08	2.77	9.71	68
25.0	3610.11	60.08	2.77	9.61	69
25.5	3610.11	60.08	2.77	9.52	71
26.0	3610.11	60.08	2.77	9.43	72
26.5	3610.11	60.08	2.77	9.34	73
27.0	3610.11	60.08	2.77	9.25	75
27.5	3610.11	60.08	2.77	9.17	76
28.0	3610.11	60.08	2.77	9.08	78
28.5	3610.11	60.08	2.77	9.00	79
29.0	3610.11	60.08	2.77	8.93	80
29.5	3610.11	60.08	2.77	8.85	82
30.0	3610.11	60.08	2.77	8.78	83

Survey Line and Sample Plot Spacing ... cont'd

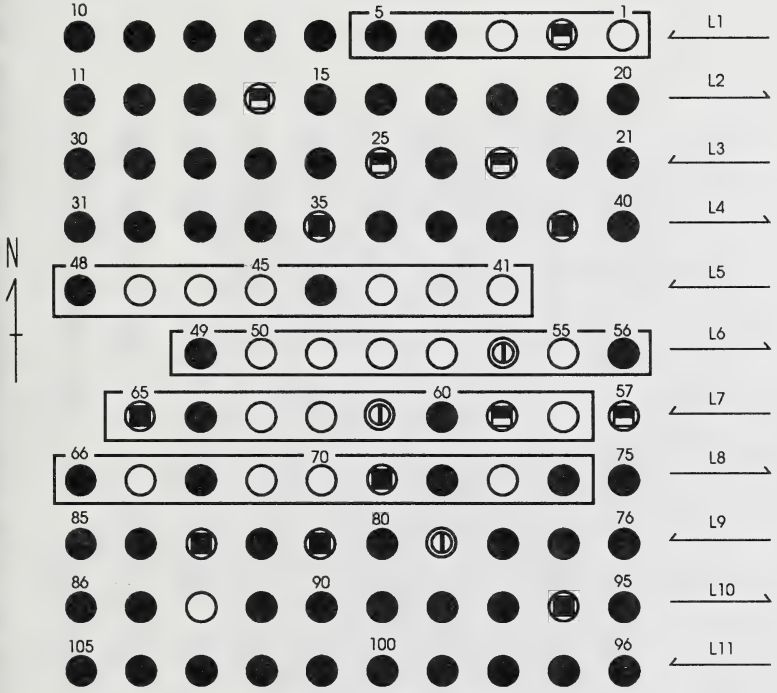
Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Allowable Error	Number of Plots
30.5	3610.11	60.08	2.77	8.70	84
31.0	3610.11	60.08	2.77	8.63	86
31.5	3610.11	60.08	2.77	8.56	87
32.0	3610.11	60.08	2.77	8.50	89
32.5	3610.11	60.08	2.77	8.43	90
33.0	3610.11	60.08	2.77	8.37	91
33.5	3610.11	60.08	2.77	8.30	93
34.0	3610.11	60.08	2.77	8.24	94
34.5	3610.11	60.08	2.77	8.18	96
35.0	3610.11	60.08	2.77	8.12	97
35.5	3610.11	60.08	2.77	8.07	98
36.0	3610.11	60.08	2.77	8.01	100
36.5	3610.11	60.08	2.77	7.96	101
37.0	3610.11	60.08	2.77	7.90	102
37.5	3610.11	60.08	2.77	7.85	104
38.0	3610.11	60.08	2.77	7.80	105
38.5	3610.11	60.08	2.77	7.75	107
39.0	3610.11	60.08	2.77	7.70	108
39.5	3610.11	60.08	2.77	7.65	109
40.0	3610.11	60.08	2.77	7.60	111
40.5	3610.11	60.08	2.77	7.55	112
41.0	3610.11	60.08	2.77	7.51	114
41.5	3610.11	60.08	2.77	7.46	115

Survey Line and Sample Plot Spacing ... cont'd

Hectares	Square Metres per plot	Square Spacing in Metres	Plots/Ha	Allowable Error	Number of Plots
42.0	3610.11	60.08	2.77	7.42	116
42.5	3610.11	60.08	2.77	7.37	118
43.0	3610.11	60.08	2.77	7.33	119
43.5	3610.11	60.08	2.77	7.29	120
44.0	3610.11	60.08	2.77	7.25	122
44.5	3610.11	60.08	2.77	7.21	123
45.0	3610.11	60.08	2.77	7.17	125
45.5	3610.11	60.08	2.77	7.13	126
46.0	3610.11	60.08	2.77	7.09	127
46.5	3610.11	60.08	2.77	7.05	129
47.0	3610.11	60.08	2.77	7.01	130
47.5	3610.11	60.08	2.77	6.97	132
48.0	3610.11	60.08	2.77	6.94	133
48.5	3610.11	60.08	2.77	6.90	134
49.0	3610.11	60.08	2.77	6.87	136
49.5	3610.11	60.08	2.77	6.83	137
50.0	3610.11	60.08	2.77	6.80	138

Figure A2.1

Example of west to east delineation of suspected NSR area *(Step 1)*



Block Information:

Area = 38 ha

Sampling intensity = 105 plots (2.77 plots/ha)

Stocked coniferous $\frac{67}{105} \times 100 = 63.8\%$

Stocked Fa/Fb + deciduous $\frac{10}{105} \times 100 = 9.5\%$

NSR plots $\frac{21}{105} \times 100 = 20.0\%$

Total Stocking = 80%

Figure A2.2

Example of north to south delineation of suspected NSR areas *(Step 2)*

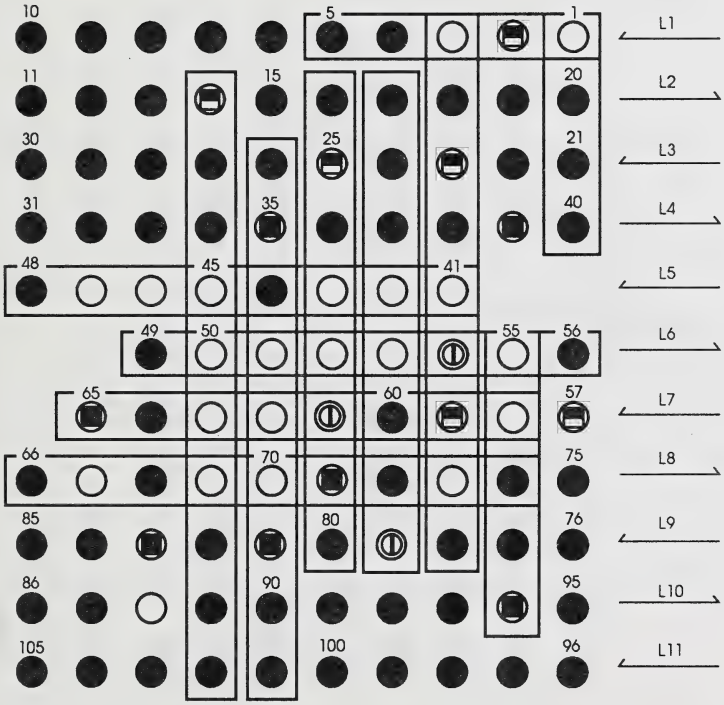


Figure A2.3

Example of delineation of overlapping areas *(Step 3)*

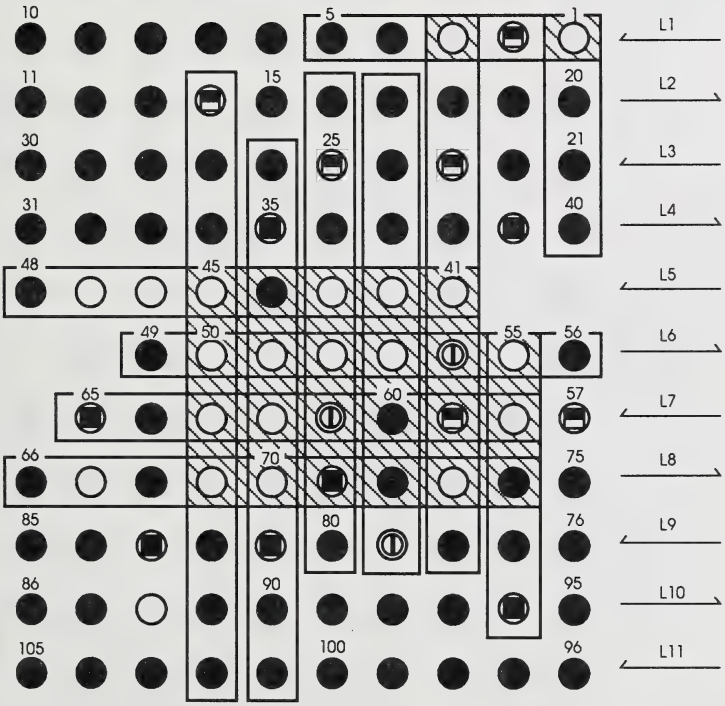
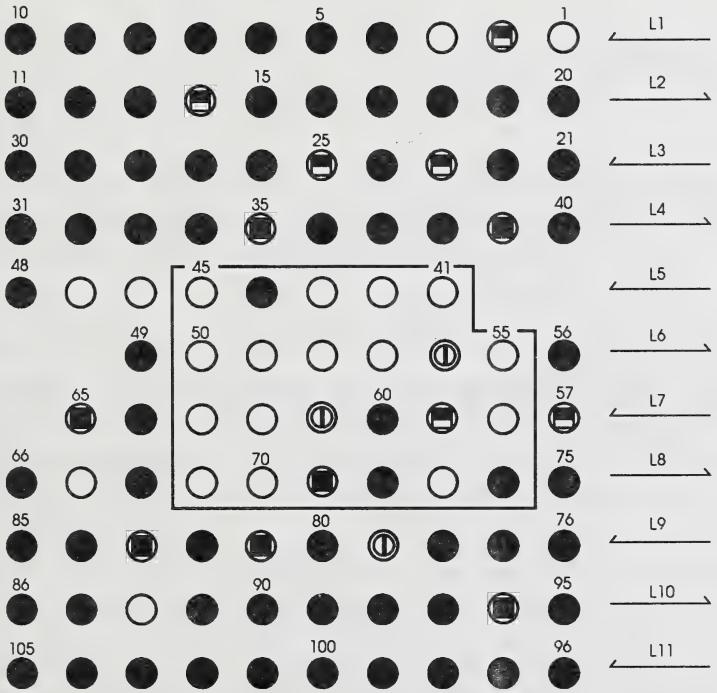


Figure A2.4

Example of final delineation of NSR areas over 4 ha *(Step 4)*



1 plot represents $\frac{38 \text{ ha}}{105 \text{ plots}}$ = 0.36 ha

NSR area 23 plot = 23 x 0.36 ha = 8.28 ha

Therefore the whole block is NSR until the NSR patch is treated and proved to be SR.

NOTE: Only those NSR areas greater than 4 ha should be delineated.

APPENDIX 3

Survey Quality

General

To ensure that regeneration surveys are performed in an accurate and complete manner, the Alberta Forest Service will undertake a program of check surveys. Any check survey must be carried out by a certified surveyor.

Plot-on-Plot Check Regeneration Surveys

For forest industry surveys carried out by certified surveyors, the check survey method used will be the "plot-on-plot" method. The check survey is to be conducted simultaneously with the original survey or, where this is not feasible, during the period that the industry surveyors are still actively carrying out survey work in the same locality.

Approximately 10% of the total blocks surveyed in a given area will be chosen at random and a minimum of 25 plots will be carefully checked in each block. A maximum of four demerit points will normally be allowed before a survey is rejected. Details of criteria for demerit points are itemized on the following page If the checker assesses more than four demerits before checking all 25 plots the survey fails and the checker need not continue with the survey check in that cutblock. The plot-on-plot survey check will be recorded and submitted on form RR143.

If, for example, 40 blocks have been regeneration surveyed, then at least four blocks (10%) would be check surveyed and 25+ plots in each of these blocks would be carefully checked. If the regeneration survey is found to be below

standard during a check survey, the entire survey of blocks in a given area may be rejected based on the judgement of the check surveyor with concurrence of his Forest Superintendent.

Criteria for Rejection of Surveys

Deductions are as follows:

a. One demerit for each missed established seedling or sapling.

b. One demerit for tallying an unacceptable established seedling or sapling; e.g., advance growth that should not have been tallied, crop tree tallied which does not meet the height standard, dead leaders on seedlings, etc.

c. One and one half demerits for tallying a tree that is outside the plot.

d. One demerit for incorrectly identifying species; e.g., calling balsam fir a spruce, etc.

e. Half demerit for inaccurate plot establishment. Ten percent error is allowed in plot spacing and line spacing.

f. Half demerit for not tying into the control line.

g. Half demerit for incorrect delineation of NSR areas.

h. Half demerit for incorrect numbering of plots or lines.

i. Half demerit for incorrect stocking grid pattern and/or incorrect map symbols.

j. Half demerit for not correctly marking plot centers in the field.

k. Half demerit for inaccurate density estimate or not recording density of trees on the plot. Variance to be + 2 trees if total less than 10 trees or + 10% if estimated total greater than 10 trees.

l. One demerit for poor mapping quality. This will also include missed information on final map.

m. One demerit for inaccurate crop tree height measurement. Height should be to the nearest cm and should be taken from the root collar to the top of the farthest reaching needle on the highest reaching leader or branch.

Rejection of a Block Survey

a. More than four (4) demerit marks will normally constitute grounds for rejection of a block.

b. Considering the seriousness of including seedlings from outside the plot boundary, two such errors will constitute grounds for rejection of the block.

Rejection of two survey blocks would constitute grounds for rejection of all blocks surveyed by that particular surveyor. Obviously, the total number of blocks involved must be considered with respect to the number of blocks failed.

Where a check survey confirms that the block stocking is SR (i.e., 80% or over), do not reject the block survey regardless of the number of demerits.

Independent Check Regeneration Surveys

Independent check surveys may be carried out only when assessing industry surveys conducted by uncertified surveyors, subject to the following:

a. Where independent check surveys are carried out, blocks to be checked must be selected at random.

b. Check surveys are to be carried out to the same intensity as the regeneration survey being checked.

The original survey results and the independent check survey results are to be compared (through calculation of the Z value) to determine whether or not the two results are "statistically the same" or are "significantly different" at the 95% confidence level. This comparison involves the calculation of a Z value for each check-surveyed block using the formula:

$$Z = \frac{P_1 - P_2}{\sqrt{\frac{P_1 q_1}{n_1} \times \frac{P_2 q_2}{n_2}}}$$

Where: P_1 = proportion of plots stocked in the original survey.

q_1 = proportion of plots unstocked in the original survey (= 1.00 - P1).

n_1 = total number of useable sample plots in theoriginal survey (not including deleted plots).

For the independent check survey, P_1, q_1 and n_1 are replaced with P_2, q_2, and n_2, respectively.

If the absolute value of Z is greater than 1.96 (round-off to 2), the two estimates are called "statistically different". When the value of Z is 2 or less, then the two estimates are called "statistically the same".

The value of Z will generally be less than 2 when the survey result falls within the range of the ± joint sampling error (E_j) of the two surveys. The joint sampling error can be calculated as:

$$E_j = \sqrt{E^2c + E^2O}$$

Where: E_c = Sampling error of check survey in percent.

E_0 = Sampling error of original survey in percent.

Individual sampling errors can be calculated by using the formula:

$$E = \pm 200 \sqrt{\frac{p \times q}{n}}$$

Where: E = Sampling error in percent.

P = Proportion of stocked plots expressed as decimal. e.g. 50% = 0.50

q = Proportion of plots unstocked = 1.00 - p

n = Number of useable plots in sample.

The number of acceptable blocks, which have significantly different results in relation to the total number checked, is shown in Table A3.1.

TABLE A3.1

The allowable number of blocks with statistically different survey results in relation to the number of blocks check-surveyed

Number of Check-Surveyed Blocks	Number of Allowable Significant Disagreements
1	0
2-7	1
8-16	2
17-28	3
29-40	4
41-53	5
54-67	6
68-81	7
82-95	8
96-110	9
111-125	10
126-140	11
141-150	12

When the number of blocks with significant disagreements exceed the values shown in Table A3.1., there is sufficient reason to suspect the accuracy of the regeneration survey, check survey, or both.

The surveyor who has completed an incorrect survey may be identified by examining the nature of disagreements on those blocks having significant disagreements. The following indicators may become apparent:

a. Stocking from the original survey is consistently higher than the check-survey stocking.

b. Stocking from the original survey is consistently lower than the check survey.

c. Approximately one-half of the original survey results are lower and approximately one-half are higher than in the check-survey results.

Situation (a) and (b) imply that one of the surveys is imprecise or biased. Situation (c) indicates that probably both surveys are imprecise or biased.

To determine which survey is biased, the location of the survey plots and their stocking status must be re-examined in the field. Should the re-examination confirm the check-survey results, there are reasonable grounds for rejection of the entire original survey.

Aside from the statistical analysis, the delineation of SR/NSR subunits is to be compared on the check-surveyed blocks. The two delineations must agree.

The recourse for the surveyor, if a survey is rejected or certification suspended, is to meet with the Forest Superintendent in whose forest the rejected survey was performed. A resolution of any disagreement must start at this level and further options may be presented to the surveyor as a result of any meetings held.

APPENDIX 4

COMMON NAME	SPECIES SYMBOL
White spruce	Sw
Engelmann spruce	Se
Black spruce	Sb
Lodgepole pine	Pl
Jack pine	Pj
Whitebark pine	Pw
Limber pine	Pf
Larch (all species)	Lt
Douglas-fir	Fd
Balsam fir	Fb
Alpine fir	Fa
Trembling aspen	Aw
Balsam (Black) poplar	Pb
White birch	Bw
Hybrid Poplar	Ax

APPENDIX 5

Species Identification

Picea glauca

White spruce

Leaves: Needle-shaped. 4-sided, 2-3 cm (1 1/4 inches) long, straight, stiff, sharp pointed, bluish-green, aromatic when crushed.

Picea engelmannii

Engelmann spruce

Leaves: Broad needle-shaped, about 3/4 inches long, stiff, blunt or sharp pointed, curved, four-sided in cross-section, bluish-green but often with a whitish bloom, aromatic when crushed; a strong tendency to point towards the upper side and end of the twig.

Twigs: More or less hairy, greyish to light brown; outer bud-scales shorter than the bud, not usually projecting beyond its tip.

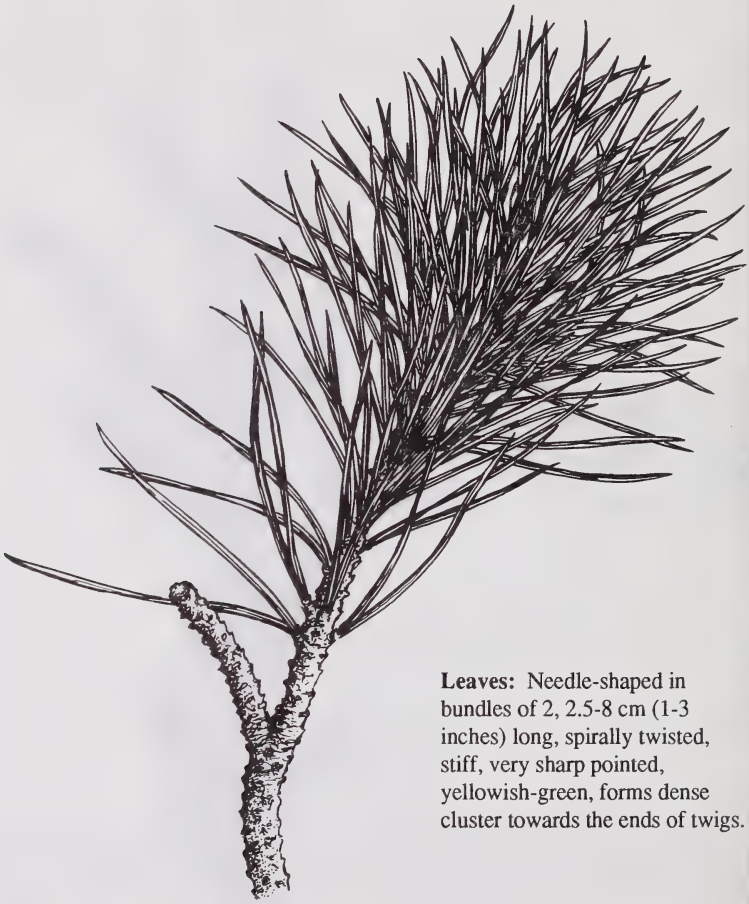
Picea mariana

Black spruce

Leaves: Needle-shaped, 4-sided, 1-2 cm (1/2 - 3/4 inches) long, straight, thick, stiff, blunt, blueish green in colour.

Pinus contorta v. latifolia

Lodgepole pine



Leaves: Needle-shaped in bundles of 2, 2.5-8 cm (1-3 inches) long, spirally twisted, stiff, very sharp pointed, yellowish-green, forms dense cluster towards the ends of twigs.

Pinus banksiana

Jack pine

Size: In closed stands on favourable sites, it reaches 80 ft. in height, with a straight trunk 2 ft. in diameter but, normally, it is 40 to 60 ft. in height and 8 to 12 inches in diameter, pointed, light, yellowish-green, spread apart, the edges toothed; clusters with persistent basal sheaths.

Pinus albicaulis

Whitebark pine

Leaves: In 5's, 1 1/2 to 3 1/2 inches long, needle-shaped, stout, stiff, slightly curved, bluish-green, the edges not toothed, clustered towards the ends of the branchlets.

Twigs: Stout, tough, usually hairy, reddish-brown to chalky-white; buds oval, sharp pointed, with overlapping loose scales.

Pinus flexilis

Limber pine

Leaves: In 5's, 1 1/2 to 3 1/2 inches long, needle-shaped, stout, stiff, slightly curved, bluish-green, the edges not toothed, clustered towards the ends of the branchlets.

Twigs: Stout, tough, at first hairy, later smooth; greenish-yellow becoming grey; buds oval, pointed, with overlapping loose scales.

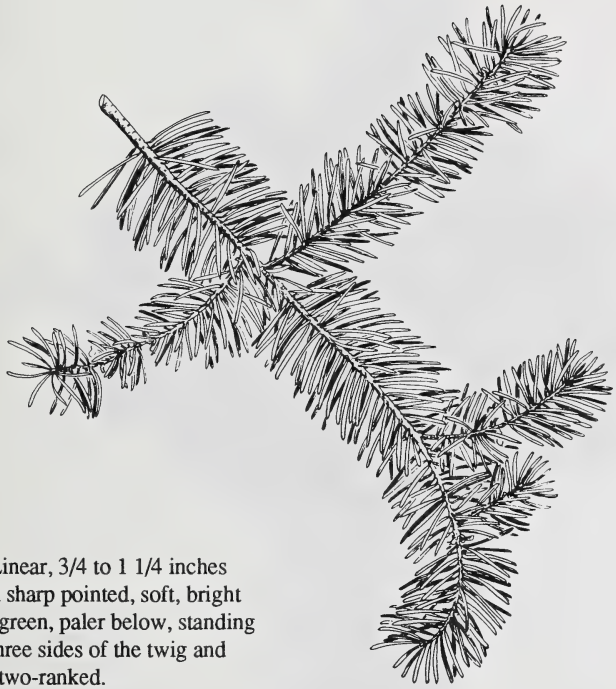
Larix laricina

Tamarack

Leaves: Needle-shaped in feather-like clusters of 10-20, 2-4 cm (3/4 - 1 1/2 inches) long, soft, flexible, pale green turning bright yellow in autumn. Sheds leaves in autumn.

Pseudotsuga menziesii

Douglas-Fir

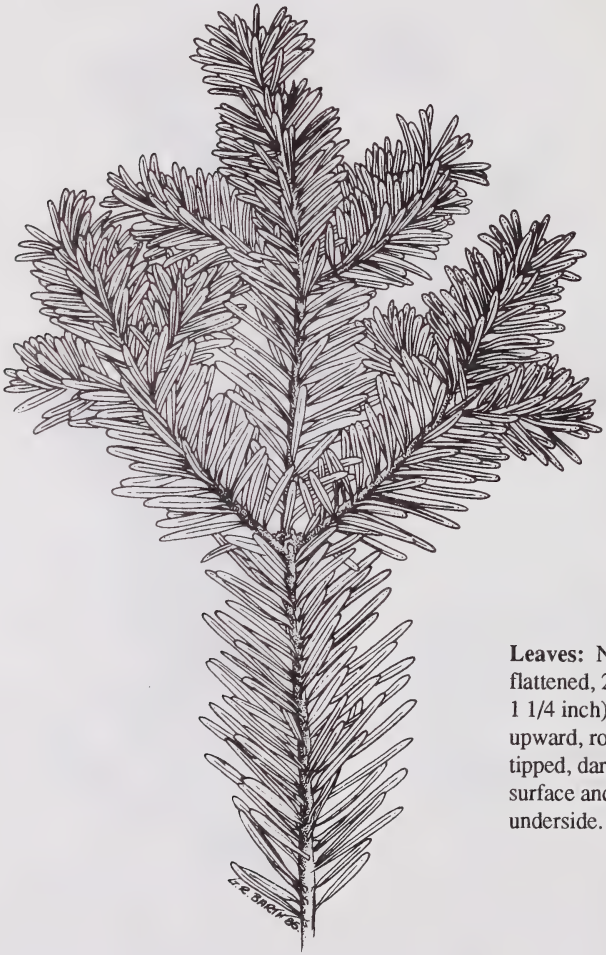


Leaves: Linear, 3/4 to 1 1/4 inches long, often sharp pointed, soft, bright yellowish-green, paler below, standing out from three sides of the twig and appearing two-ranked.

Twigs: Slender, flexible; buds conical, sharp pointed, shiny reddish-brown.

Abies balsamea

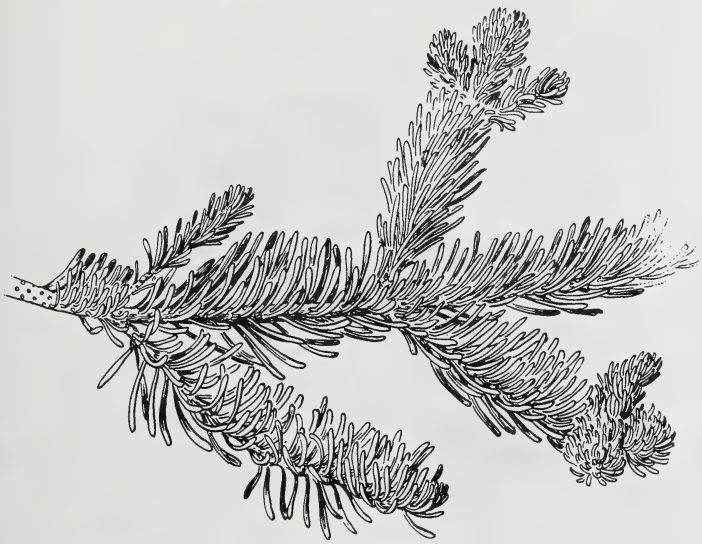
Balsam fir



Leaves: Needle-shaped, flattened, 2-3 cm (3/4 - 1 1/4 inch) long, bent upward, rounded or blunt tipped, dark shiny green surface and whitish underside.

Abies lasiocarpa

Alpine fir



Leaves: Greyish-green to pale bluish-green above and below, with many markings (stomata) on both surfaces. 1 to 1 3/4 inches long, rounded or notched at the tip, curved upwards to stand almost erect along the twig, crowded, seldom two-ranked; resin canals in the internal tissue as viewed in the cross-section of the leaf.

Twigs: Stout, hairy, brownish, becoming greyish, but retaining the hairiness usually for several years; buds 3/16 inches long, rounded and covered with a wax-like resin.

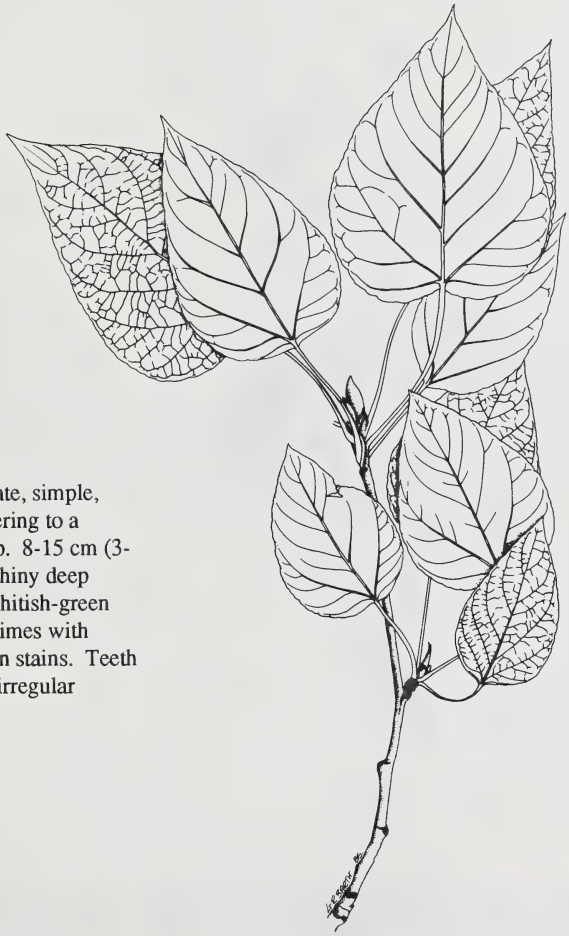
Populus tremuloides

Trembling aspen

Leaves: Alternate simple, rounded, abruptly pointed at tip, 4-6 cm (1 1/2 - 2 1/2 inches) wide. Teeth on margin fine, irregular, rounded. Leaf stem slender, flattened, usually longer than the leaf-blade, shiny deep green on top, paler under.

Populus balsamifera

Balsam poplar



Leaves: Alternate, simple, egg-shaped, tapering to a sharp-pointed tip. 8-15 cm (3-6 inches) long, shiny deep green surface, whitish-green underside sometimes with rusty brown resin stains. Teeth on margin fine, irregular rounded.

Betula papyrifera

White birch

Leaves: Alternate, simple, egg-shaped, 2-9 cm (3/4 - 3 1/2 inches) long, dull green upper surface, paler, slightly hairy underside. Margins toothed except near the base.

Alnus crispa

Alder

Leaves: Alternate, simple, ovate, 2-8 cm (1-3 inches) long, fine, sharp teeth on margins, prominent veins, shiny green upper surface, paler underside, sticky when young.

Fruit: Small conelike catkins on long stalks, several in a cluster, green turning brown at maturity. Nutlets with wings.

Salix spp.

Willows

Leaves: Alternate simple long, narrow, pointed at both ends. Teeth on margins.

Note: Various species will be encountered which may make identification difficult.

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